

AD-A054 750

ARINC RESEARCH CORP SANTA ANA CALIF
A COMPUTERIZED COMMAND AND CONTROL SYSTEM FOR THE LOS ANGELES C--ETC(U)
DEC 67 D J NIELSEN, H G RYLAND
4826-851

F/G 13/12

UNCLASSIFIED

NL

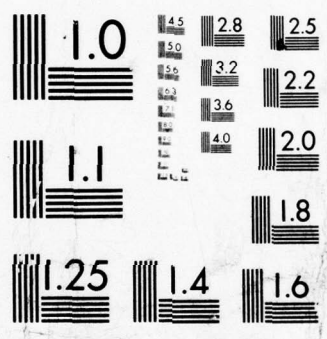
| OF |

AD
A054 750



END
DATE
FILMED
7-78

DDC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

FOR FURTHER TRAN *TH*

AD A054750

3
SC

6
A COMPUTERIZED COMMAND AND CONTROL SYSTEM
FOR THE LOS ANGELES CITY FIRE DEPARTMENT

11
December 1967

12
25p

DDC
JUN 6 1978
F

AD NO.
DDC FILE COPY

10
Prepared by
D. J. Nielsen
Chief Communications Officer
LOS ANGELES CITY FIRE DEPARTMENT

H. G. Ryland
ARINC RESEARCH CORPORATION
Santa Ana, California

This document has been approved
for public release and sale; its
distribution is unlimited.

14
Publication No. 4826-851

400 711

AB

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER 4826-851 ✓	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) A COMPUTERIZED COMMAND AND CONTROL SYSTEM FOR THE LOS ANGELES CITY FIRE DEPARTMENT		5. TYPE OF REPORT & PERIOD COVERED
		6. PERFORMING ORG. REPORT NUMBER 4826-851
7. AUTHOR(s) D.J. Nielsen H.G. Ryland		8. CONTRACT OR GRANT NUMBER(s) Not Listed
9. PERFORMING ORGANIZATION NAME AND ADDRESS ARINC Research Corporation ✓ 2551 Riva Road Annapolis, Maryland 21401		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS NONE		12. REPORT DATE December 1967
		13. NUMBER OF PAGES 24
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) NONE		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) UNCLASSIFIED/UNLIMITED		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number)		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number)		

DD FORM 1473

1 JAN 73

EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

1. REPORT NUMBER	4826-851
2. TYPE OF REPORT & PERIOD COVERED	A COMPUTERIZED COMMAND AND CONTROL SYSTEM FOR THE LOS ANGELES CITY FIRE DEPARTMENT
3. AUTHOR(S)	D.J. Nielsen H.G. Ryland
4. PERFORMING ORGANIZATION NAME AND ADDRESS	ARINC Research Corporation 2551 Riva Road Annapolis, Maryland 21401
5. CONTRACT OR GRANT NUMBER(S)	Not Listed
6. PERFORMING ORGANIZATION REPORT NUMBER	4826-851
7. AUTHOR(S)	None
8. PERFORMING ORGANIZATION NAME AND ADDRESS	None
9. CONTRACT OR GRANT NUMBER(S)	None
10. PERFORMING ORGANIZATION REPORT NUMBER	None
11. REPORT DATE	December 1967
12. NUMBER OF PAGES	24
13. SECURITY CLASSIFICATION OF REPORT	UNCLASSIFIED
14. SECURITY CLASSIFICATION OF ABSTRACT	UNCLASSIFIED
15. DISTRIBUTION STATEMENT (of the Report entered in Block 14)	UNCLASSIFIED/UNLIMITED
16. SUPPLEMENTARY NOTES	
17. DISTRIBUTION STATEMENT (of the Abstract entered in Block 14)	
18. ABSTRACT	
19. ABSTRACT	
20. ABSTRACT	
21. ABSTRACT	
22. ABSTRACT	
23. ABSTRACT	
24. ABSTRACT	
25. ABSTRACT	
26. ABSTRACT	
27. ABSTRACT	
28. ABSTRACT	
29. ABSTRACT	
30. ABSTRACT	
31. ABSTRACT	
32. ABSTRACT	
33. ABSTRACT	
34. ABSTRACT	
35. ABSTRACT	
36. ABSTRACT	
37. ABSTRACT	
38. ABSTRACT	
39. ABSTRACT	
40. ABSTRACT	
41. ABSTRACT	
42. ABSTRACT	
43. ABSTRACT	
44. ABSTRACT	
45. ABSTRACT	
46. ABSTRACT	
47. ABSTRACT	
48. ABSTRACT	
49. ABSTRACT	
50. ABSTRACT	
51. ABSTRACT	
52. ABSTRACT	
53. ABSTRACT	
54. ABSTRACT	
55. ABSTRACT	
56. ABSTRACT	
57. ABSTRACT	
58. ABSTRACT	
59. ABSTRACT	
60. ABSTRACT	
61. ABSTRACT	
62. ABSTRACT	
63. ABSTRACT	
64. ABSTRACT	
65. ABSTRACT	
66. ABSTRACT	
67. ABSTRACT	
68. ABSTRACT	
69. ABSTRACT	
70. ABSTRACT	
71. ABSTRACT	
72. ABSTRACT	
73. ABSTRACT	
74. ABSTRACT	
75. ABSTRACT	
76. ABSTRACT	
77. ABSTRACT	
78. ABSTRACT	
79. ABSTRACT	
80. ABSTRACT	
81. ABSTRACT	
82. ABSTRACT	
83. ABSTRACT	
84. ABSTRACT	
85. ABSTRACT	
86. ABSTRACT	
87. ABSTRACT	
88. ABSTRACT	
89. ABSTRACT	
90. ABSTRACT	
91. ABSTRACT	
92. ABSTRACT	
93. ABSTRACT	
94. ABSTRACT	
95. ABSTRACT	
96. ABSTRACT	
97. ABSTRACT	
98. ABSTRACT	
99. ABSTRACT	
100. ABSTRACT	

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

CONTENTS

ACCESSION for	
NTIS	Write Section <input checked="" type="checkbox"/>
DDC	B. ff Section <input type="checkbox"/>
UNANNOUNCED	<input type="checkbox"/>
JUSTIFICATION	
BY	
DISTRIBUTION/AVAILABILITY CODES	
Dist.	SPECIAL
A	

	<u>Page</u>
1. BACKGROUND AND OBJECTIVES	1
2. SYSTEM OPERATIONAL REQUIREMENTS	3
2.1 General Requirements	3
2.2 Major System Functions	4
2.2.1 Maintaining Status of Units	4
2.2.2 Identification of Appropriate Assignments	4
2.2.3 Maintaining Status of Incidents	6
2.2.4 Automatic Control of Communications	6
2.2.5 Automatic Recording of Dispatching Activities	6
2.2.6 Storage and Retrieval of Maps and Procedures	6
3. SYSTEM DESIGN AND OPERATION	7
3.1 System Description	7
3.2 Unit Status Function	9
3.2.1 Status Information Input	10
3.2.2 Status Displays	11
3.3 Unit Assignment Function	12
3.3.1 Information Input	12
3.3.2 Assignment Identification	16
3.4 Incident Status	17
3.5 Communications Control	18
3.6 Automatic Recording	19
3.7 Storage and Retrieval of Maps and Procedures	19
4. SYSTEM RELIABILITY	20
5. HUMAN FACTORS	21
6. CONCLUSION	22

LIST OF ILLUSTRATIONS

<u>Figure</u>	<u>Title</u>	<u>Page</u>
1	Functional Diagram, LAFD C&C System	5
2	Dispatch Console	8
3	Example of CRT Display - Status of Battalion 16	13
4	Example CRT Display Typical Assignment	14
5	Example of CRT Display - Street Index File	15
6	Example CRT Display - Incident Status	18

1. BACKGROUND AND OBJECTIVES

The present dispatching and alarm system of the Los Angeles City Fire Department (LAFD) was originally designed in the mid-1920's. At that time the design was adequate, considering the size of the LAFD and the state of art of operating equipments and techniques. The system has since undergone various degrees of modification because of the increasing number and complexity of the demands placed upon it. During the past 20 years the City has experienced a population growth of more than 50 percent and the alarm rate in the Los Angeles area has quadrupled.

The inadequacies of the present system were graphically pointed out by the catastrophic Bel Air Fire in late 1961, the Watts riots of 1965, and other tragic events of recent years. Efforts to increase system efficiency had long since reached the point of diminishing returns. It became apparent that a new, bold approach was needed in the area of fire-department command and control. However, with few exceptions the fire agency does not retain system design engineers for development assignments, nor are sufficient funds available for the purpose. For this reason, Chief Engineer Raymond M. Hill of the LAFD requested the city to authorize funds for an outside agency to make an in-depth engineering evaluation of the LAFD dispatching capabilities and to determine the needed changes in system design, operation, planning, and maintenance to meet present and future requirements. Seven aerospace system developers studied the problem and expressed interest in conducting such an evaluation. In May 1967 the City of Los Angeles, through its Department of Public Utilities and Transportation, entered into contract with ARINC Research Corporation for the preparation of a design for a command and control terminal system for the LAFD. Specific tasks were:

- a. To design a system having acceptable reaction time and sufficient capacity for current and anticipated demands;

- b. To determine the availability of off-the-shelf equipment for implementing the system;
- c. To develop the necessary design specifications for interfacing, inter-connecting, or otherwise integrating the equipment to constitute the terminal system; and
- d. To develop a technical procurement package sufficient to acquire, install, test, and implement the system.

Beneficial features of the new system are many and varied. For example:

- The present system requires that numerous steps be taken to deploy the fire-fighting force--each step manually executed, each consuming precious time, and each vital to the success of a mission. Consequently, the basic objective of the new approach is to simplify and automate the predetermined command and control procedures so as to minimize the time, manpower, and probability of error in deploying the force. Within the constraints of required judgmental decisions automation is incorporated to an optimum degree.
- Automatic displays are provided to augment the dispatcher's memory and obviate his need for mentally maintaining the status of men and apparatus.
- Rapid access to needed data will allow the Command and Control Center personnel to provide accurate information to firefighting personnel quickly, and to enter more effectively into the field operation.
- Pre-programmed automatic printouts will greatly simplify record keeping and provide a ready source for operational and statistical data.

Other important objectives of the proposed effort were design simplicity, ease of maintenance, reliability, low cost, and flexibility. Fundamentally, the system must respond rapidly and effectively to the demands imposed upon it, and must incorporate features which will enable it to interface effectively with corresponding systems of adjacent municipalities and with other interested departments of the City of Los Angeles.

2. SYSTEM OPERATIONAL REQUIREMENTS

2.1 GENERAL REQUIREMENTS

The first step in the development of an advanced Command and Control (C&C) System for the LAFD was to establish the Department operational requirements and the corresponding functions to be provided by the C&C System. These functions had to be identified accurately and in sufficient detail to ensure that the resulting system would satisfy all operational requirements.

The system requirements and functions were established through a relatively detailed live-in analysis of dispatching and field operations of the LAFD and a more cursory survey of several of the more advanced city fire department dispatch systems, such as the one in Phoenix, Arizona. Realizing that because of financial and other constraints it might not be possible for the city to acquire the entire Command and Control System at one time, the required and desired functions were ranked in priority order. This would allow the city to acquire initially the functions that are urgently needed and then add additional functions as circumstances permit.

As a result of this analysis, both general and specific system functional requirements were established. The general requirement was that any dispatcher be able to handle incidents of any type or magnitude--from receipt of alarm to final disposition--at any console position. This will eliminate the time-consuming movement of personnel inherent in the present dispatch procedures of most fire departments. Therefore to satisfy the established requirements each console must have:

- a. Fire alarm box readout
- b. Incoming public-telephone trunk lines
- c. Direct telephone links to other agencies, such as police, hospital, public utilities, and other fire departments
- d. Communication links to all fire stations
- e. Radio links for all fire department frequencies

- f. Rapid access to the street index
- g. Rapid access to detailed maps and emergency procedures
- h. Rapid access to location and status information for all LAFD units
- i. Rapid access to information concerning incidents being handled at other console positions
- j. Communication links to other console positions.

2.2 MAJOR SYSTEM FUNCTIONS

The operational requirements of the C&C System are discussed briefly in the following paragraphs. These requirements are allocated to major system functions in the manner shown in Figure 1.

2.2.1 Maintaining Status of Units

The analysis of dispatching operations revealed that keeping track of the status of the various LAFD units (companies, and battalion and division chiefs) was probably the most needed system function. Dispatch personnel should be able to rapidly determine the location and status of all fire department companies and chiefs--especially during periods of high activity. This requires that the dispatcher have immediate access to the availability and location of each unit and the means of contacting it. To the maximum degree possible, unit status information should be maintained without the attention of dispatch personnel. A change in status, therefore, should be entered into the C&C System automatically or directly by the unit concerned.

2.2.2 Identification of Appropriate Assignments

The second major system function is that of rapidly identifying the appropriate available assignment for each incident handled by the LAFD. This function should eliminate the need for dispatch personnel to manually identify assignments from the street index and running cards and then determine the availability of the needed LAFD units. The assignment identified by the system should be appropriate with

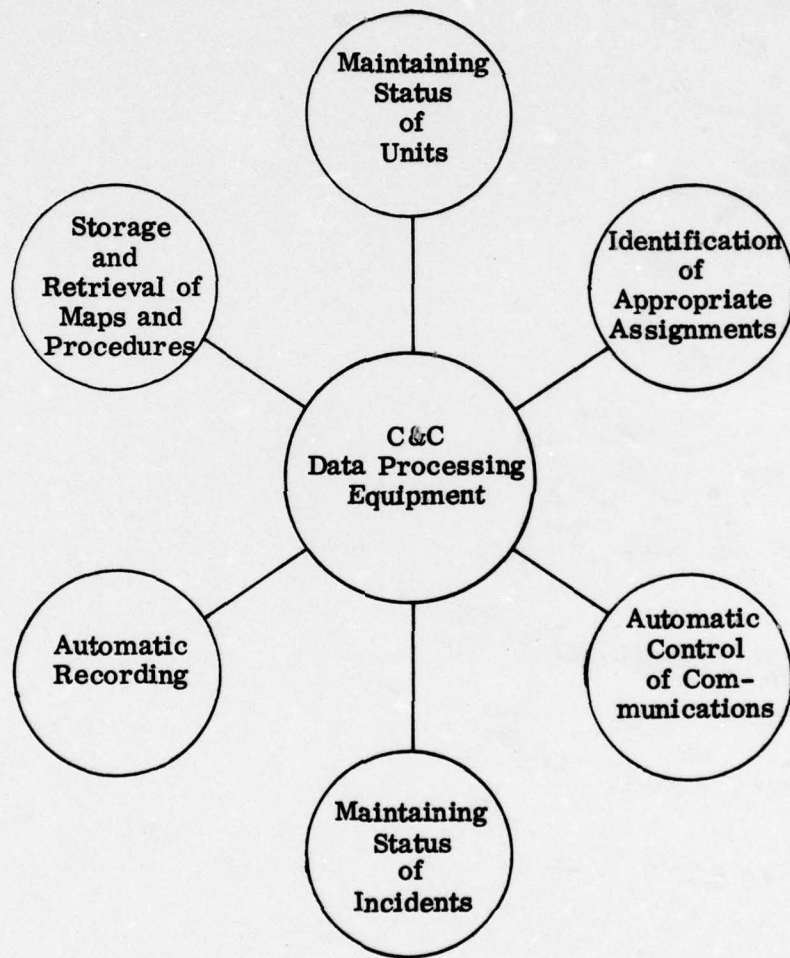


Figure 1. Functional Diagram, LAFD C&C System

respect to the type, magnitude, and location of the incident. This function should also identify company move-ups as they become appropriate. Since each unit in the identified assignment would be available, the function should automatically identify fill-in units for those which would ordinarily respond to a specific location but are not available.

2.2.3 Maintaining Status of Incidents

The status of each active incident should be automatically maintained by the C&C System and displayed to dispatch and command personnel as requested. This information would permit dispatchers to immediately identify multiple calls for a common incident, and would provide command personnel with information concerning the overall status of the city with respect to LAFD responsibilities.

2.2.4 Automatic Control of Communications

The C&C System should automatically establish communication links with which to dispatch the units in an assignment. These links would include landline voice, radio voice, and teletype.

2.2.5 Automatic Recording of Dispatching Activities

Many dispatching and related activities performed by the C&C System should be automatically recorded, which would release LAFD personnel from having to complete a number of routine forms.

2.2.6 Storage and Retrieval of Maps and Procedures

Detailed street maps, utility distribution maps, and emergency procedures should be maintained by the system and rapidly identified and displayed as needed. These maps, displayed at the dispatcher consoles, would be extremely valuable in identifying the locations of incidents which are not related to intersections or street numbers, and also in directing companies to the scene of an incident.

3. SYSTEM DESIGN AND OPERATION

Several important ground rules were established prior to the system design effort to ensure that the C&C System would satisfy all requirements, standards, and applicable regulations. These rules are discussed below.

- a. Manual Backup – Every system function must have at least one manual backup in case of equipment failure.
- b. Normal and Emergency Operations – The major emergency operation of the C&C System must not differ significantly from normal operation, so that operating personnel will not become confused as to operational procedures when a major emergency arises.
- c. Graceful Degradation – The design of the system and operating procedures must be such that individual equipment malfunctions only gradually reduce operating capability and do not change operating procedures.
- d. Operator Training – The system must be operable by present dispatch personnel with a maximum of two weeks' additional training.
- e. Present Equipment – Present equipment possessed by the City must be utilized to the maximum extent possible, where such use is consistent with operational requirements and constraints.
- f. Modular Construction – The system will be designed in terms of "building blocks", such that it can be procured and implemented on an incremental basis.

The system design concept is described in Section 3.1 in terms of its individual functions.

3.1 SYSTEM DESCRIPTION

The LAFD Command and Control System will permit any individual dispatcher to receive emergency calls, dispatch appropriate assignments, and handle other

command and control functions. Such single-point operation requires that all sources of information and all communication links be instantly available to each dispatcher. The system design for rapid and multiple access is therefore based on the use of a digital computer and other data-processing equipment with associated input/output consoles. A dispatch console will contain a cathode ray tube (CRT) display, a microfilm display, a color-coded unit status display, input keyboard, and radio and telephone communications controls. Figure 2 is a sketch of the console.

The C&C System can be operated either automatically or semiautomatically in that the dispatcher may exercise complete control over all functions, and may alter or even eliminate any action proposed by the system. Toward this end, the dispatcher is provided with instantaneous and comprehensive information and communication links to facilitate positive, rapid dispatch decisions and to take other appropriate actions. Manual backup and checkout capabilities are provided for each system function to ensure that C&C operations will continue in the event of failure of data processing or other equipment.

The system was designed in terms of logical building blocks, or functions, which will permit its procurement and implementation on an incremental basis--that

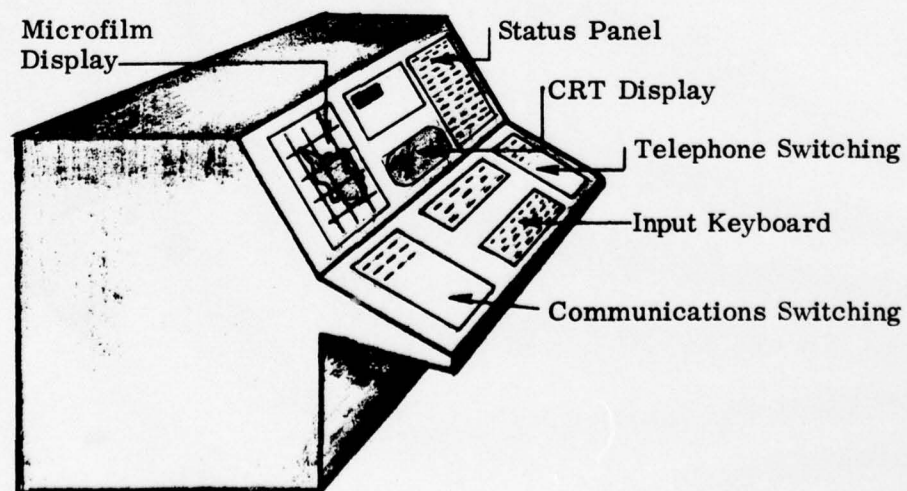


Figure 2. Dispatch Console

is, the most important subsystem can be installed initially, with the others added as financial and other constraints permit. The system design concept is described below in more detail in terms of the major system functions.

3.2 UNIT STATUS FUNCTION

The unit status function of the C&C System will maintain status and location information for all LAFD companies, chiefs, and other personnel as required. This information will be maintained by the system computer according to the following basic status states:

- a. In-house and available – The unit is in its normally assigned quarters and can be dispatched over the normal communication channels.
- b. Out of house but available by radio – The unit is within its normal response district and is available for assignment, but must be dispatched by radio.
- c. Assigned to an incident – The unit has responded to a dispatch and is not available for further assignment.
- d. Out of service but available – The unit is temporarily engaged in some activity (training for example), but could respond in an extreme emergency.
- e. Out of service and not available – The unit is not available for assignment under any circumstances (for example, the equipment is inoperable or the unit is not manned).

In addition to these basic status states, three additional states were established for units on special assignments. These additional states include:

- a. Moved-up – A unit temporarily operating out of another unit's quarters.
- b. Split – A two-piece company temporarily split into two individually manned and responsible units.
- c. Task Force – Two or more companies and a Battalion Chief temporarily assigned to respond as a group.

The status information maintained by the C&C System will be instantly available to dispatch and command personnel as needed. Unit status changes will be automatically entered to the maximum extent possible, with provision for manual entry from each dispatch and an administrative console. This will provide (1) a means for entering status changes which are received verbally, and (2) a back-up for the automatic methods. The system computer will receive status information from several different sources, but certain states will be available only from computer memory and will not be shown on every status display, and certain status changes can be made only through the consoles.

3.2.1 Status Information Input

Unit status changes will be made by field, dispatch, and other personnel using the following methods:

- a. Automatic answer-back -- For companies dispatched while in quarters, automatic confirmation that they have responded will be effected by the fire apparatus rolling over a specially armed switch in leaving the station. The dispatcher will receive an alarm if an assigned unit does not respond within a given interval. This answer-back signal changes the company status from "in-house and available" to "assigned to an incident".
- b. Computer -- Certain status changes are implicit in the dispatching process and will be entered as a by-product of unit-assignment and incident-status monitoring. The computer will automatically change the status of units assigned to an incident or moved up by the system. These changes will only be from "in-house and available" or "available by radio" to "assigned to an incident" or "moved up". For these status changes, no action will be required from any C&C or field personnel.

- c. Status change keyboards – This keyboard, one of which is located in each fire station, will include switches for unit identification and each of the basic status states. Thus a unit can identify itself and change its state without action by the dispatcher. Changes in status by units in the field will be reported by radio, and entered manually at a console. Non-emergency status changes will utilize an administrative frequency and C&C console to conserve air time and dispatch capability.
- d. Manual capability – If desired, the status of each unit can be changed within the basic states by a corresponding status switch at each console. This method will be used only in event of failure of the other methods, if the dispatcher wishes to change an assignment, or if he receives verbal status information. This manual capability can also be used as an interim operational mode if the automatic mode is not initially installed.

3.2.2 Status Displays

Unit status information will be displayed primarily on the console CRT displays. In addition, status information, for the basic states, controlled by the computer will be instantaneously and continually displayed on a large status board using color codes.

Additional status information (other than the basic states) will be maintained by the system for certain states, which will be available only by console CRT display. For example, the status of those units available only by radio will be accompanied by the frequency they are monitoring and the response district in which they are located; for units available by commercial telephone, the phone number will be given. This additional information will be manually entered into the system.

The console displays will provide dispatch and command personnel with the various status displays needed in LAFD operations. The following status groups are typical of those which can be displayed:

Battalions (e.g., Battalion 16; see Figure 3)

Division and battalion chiefs

Task force assignments, splits, and move-ups

Task force status (denoted by the assigned identification number of the task force)

Various statistical totals by unit type and status category

Figure 3 presents a typical CRT status display and illustrates most of the different status states which would be included in actual operation. To conserve computer storage the status displays will utilize mnemonic codes, which can easily be read after a minimum of explanation. A description of how this particular display would be read is also presented.

3.3 UNIT ASSIGNMENT FUNCTION

Automatically or on dispatcher demand, the C&C System will identify and display the appropriate assignment for a specific incident, basing the assignment on the type of incident, its severity, and its location. For example, in identifying the appropriate assignment the system will take into account the source of the alarm, such as a call box; or the incident type, such as a structure fire, brush fire, automobile fire, heart attack etc. The incident type is entered into the system by the dispatcher through the console keyboard.

3.3.1 Information Input

When an incident code is entered into the system, generally through the depressing of a single key, the incident description will appear in written-out form on the CRT display (example: Structure Fire-1), along with the time of alarm, for

BC16-AVAIL/RAD F4 B3
E38-AVAIL
T38-AVAIL/RAD F3
E40-IN19 LOC 5271673 RES
T40-TSKF 40 AVAIL Q40
E49-OUT/AVAIL DRTR21 PH 6245211
B1-OUT/NOT
B2-MOV UP B1 AVAIL
B3-SPLT B3-AVAIL B203 - IN19 LOC 5271673 RES

NOTE

These status codes would be read as follows:

1. Battalion Chief 16 is available by radio on frequency 4 in Boat 3's district
2. Engine 38 is in-house and available
3. Truck 38 is available by radio and is monitoring frequency 3
4. Engine 40 is assigned to incident 19 (a rescue) at map coordinate location 5271673
5. Truck 40 is assigned to Task Force 40 which is in-house and available
6. Engine 49 is out of service but available by landline at Drill Tower 21 - phone 6245211
7. Boat 1 is out of service and not available
8. Boat 2 has moved up to Boat 1's quarters and is available
9. Boat 3 has split into (a) Boat 3, which is available in quarters; and
(b) Boat 203, which is assigned to incident 19 (a rescue) at location 5271673
(Boat Company Number 3 would have to consist of two fire boats to be split.)

Figure 3. Example of CRT Display - Status of Battalion 16

verification by the dispatcher (see Figure 4). If a particular incident requires special information, such as a phone number, an appropriate reminder will appear on the screen.

INC-5

1745

STRUCTURE FIRE-1

221 S NEWTON ST X MAIN ST

LOC 4681752

ASSIGNMENT-1

E20 E32*T20 BC11(F2)

MOVE-UP

E64 Q32 T39 Q20

NOTE

This display would be read as follows:

1. This is incident number 5 and it was initiated at 1745 hours.
2. The incident is a first-alarm structure fire.
3. The address of the incident is 221 So. Newton St., and the nearest cross street is Main St.
4. The map coordinate code for this location is 4581752.
5. The appropriate first-alarm assignment is - Engine 20, Engine 32 (the asterisk indicates a move-up company), Truck 20, and Battalion Chief 11 who is available only by radio and is monitoring frequency 2.
6. Move-up units suggested are Engine 64 move to 32's quarters and Truck 39 move to 20's quarters.

Figure 4. Example CRT Display Typical Assignment

Next, the location of the incident will be entered through the console keyboard using any of the following sources of information:

Exact address	Freeway intersection
Approximate address	Map location code
Street intersection	Alarm box identification number (entered automatically)

If the dispatcher does not want to type the address into the computer, he can request the appropriate street index file, from computer memory, to appear on his CRT display and then select a location with his movable display pointer (cursor), as shown in Figure 5. The assignment will be for that approximate location, with the dispatcher adding more specific dispatch information for the assigned units verbally.

```
MAIN ST N
100 X 1 ST LOC 3842179
200 X 2 ST LOC 3842179
300 X 3 ST LOC 3842180
400 X 4 ST LOC 3842180
500 X 5 ST LOC 3842181
600 X 6 ST LOC 3842181
700 X 7 ST LOC 3842182
800 X 8 ST LOC 3842183

MAIN ST S
9500 X 95 ST LOC 3842253
9600 X 96 ST LOC 3842254
9700 X 97 ST LOC 3842255
9800 X 98 ST LOC 3842258 COUNTY STARTS 9815

MALABAR ST
--> 2400 X OAK ST LOC 3843566
2500 X ELM ST LOC 3843567
2600 X MAPLE ST LOC 3843568 EVEN NO. SANTA MONICA
```

Figure 5. Example of CRT Display - Street Index File

All location information by the dispatcher will be presented on the CRT display for verification, and will not be committed to the computer until the enter key has been pressed.

After the incident type and location are entered, the computer will perform the following functions:

- a. Verify that the street number and cross street, if provided, are valid and compatible. (If the cross street has not been entered, it will be automatically displayed by the computer.)
- b. Verify that the incident is within the LAFD's geographical area of responsibility (if not, the responsible fire department is designated).
- c. Determine if there is another, similar incident in the vicinity. (This is to ensure that this is not a multiple call from a reported incident.)

3.3.2 Assignment Identification

Available units (normally in-quarters or within first-in district) will be selected for assignment and displayed on the CRT. If a unit in the standard assignment is not available, the computer will automatically select an alternate fill-in company. Companies operating out of other than their permanent station (move-ups) will be identified by an asterisk on the assignment display (see Figure 4). Thus the Unit Assignment function must interface with the Unit Status function to determine the availability of units. If, with this dispatch, move-ups become appropriate, they will also be identified by the computer as shown in Figure 4.

Assigned units available only by radio will include the monitoring frequency on the assignment display (see Figure 4). The assignment will not be dispatched until a Dispatch key is depressed. The time of dispatch is then automatically entered and the assignment transmitted to all stations over the teletype network. However, only the units in the assignment will receive an alarm signal.

In some instances the dispatcher may not want to dispatch the assignment designated by the computer. He can eliminate a unit by depressing the unit's status switch on the console and substitute a new unit by pressing its status switch. Working from these dispatcher inputs, the computer will delete and add units to the assignments.

When the assignment is dispatched, the status of the assigned units and the status boards are automatically updated by the computer.

Subsequent assignments or additional units can be automatically dispatched to an incident using only the incident number and the new incident type code (example, Structure Fire-2). The additional assignment is identified and displayed, along with any necessary move-ups, for review by the dispatcher. When the dispatch key is again depressed the assigned units and move-ups will automatically be dispatched.

3.4 INCIDENT STATUS

The status of all active incidents will be automatically maintained by the C&C System and displayed selectively or in concert at the consoles upon request. The selective information will permit dispatchers to immediately identify multiple calls for a common incident, and the concert information will appraise command personnel of the overall status of Fire Department emergency activities.

For each incident handled by the C&C System, the computer will automatically assign an incident number under which all information concerning that incident will be stored. The status of all active and inactive incidents will be maintained in storage for the incident duration or for a specified time period and active incidents displayed on the console CRT's as requested, typically presenting the following information (see Figure 6):

Incident number	Assignment
Incident type	Occupancy (if available)
Location (address, cross-street)	Status (as received)

ACTIVE INCIDENTS

**INC5 SF1 HYPERION AV X UDELL CT
LOC 4681752 E35 E56 T35 S32 BC19**

**INC6 GF 1700 MAIN ST X 1ST
LOC 3221479 E47**

**INC8 WD CRENSHAW ST X IMPERIAL AV
LOC 6281997 E64 UNCON**

**INC10 RES 2350 OAK ST X OLIVE ST
LOC 5162384 R100**

**INC12 BF1 N SANTA ANA FRW X INDIANA ST
LOC 2144581 E2**

Figure 6. Example CRT Display – Incident Status

This incident status information can be requested and displayed at any console position for all active or specific incidents.

3.5 COMMUNICATIONS CONTROL

The C&C System will automatically establish communication links to appropriate locations necessary to dispatch specific assignments. These communications links will consist of:

- a. Teletype links that will print out an assignment at all stations and at other selected locations;
- b. Links necessary to provide an alarm signal at those stations containing units included in the assignment; and
- c. Audio links necessary to accomplish voice dispatching over the public address system in those stations containing units included in the assignment or by means of radio calls to assigned units in the field.

When the assignment is dispatched by the computer, coded signals will initiate appropriate switching to establish teletype and telephone audio circuits to the fire

houses and radio circuits to field units. The assignments will be printed at every fire house; however, only those houses which contain assigned units will receive an appropriate alarm signal.

Telephone and radio links can be also established manually from each console position for manual dispatching and other communication requirements.

3.6 AUTOMATIC RECORDING

All information relating to incidents handled by the C&C System will be automatically stored during the normal operating process and, except for unique disposition information such as damage or injuries, will not require attention from C&C personnel. Each storage record will contain a complete history of all incidents that occurred during a shift, including the console positions and dispatch personnel involved.

Information on the tapes can be printed on a teleprinter any time it is needed. Normally, the magnetic tape will be removed at the start of each shift and replaced with a fresh tape. The tape record for the previous shift will be processed using computer programs developed for that purpose. The resulting summary data will include:

- a. A complete chronological history of each incident handled during the shift, and
- b. Other data or statistical analyses required for LAFD statistical reporting.

3.7 STORAGE AND RETRIEVAL OF MAPS AND PROCEDURES

Maps, emergency operating procedures, and other information required for C&C operations will be photographed on microfilm and displayed at any console when needed. The primary functions of the console Map Display will be to provide city and county map sections necessary to identify the exact location of an incident that has been reported in a general area and to assist field personnel in various ways. For example,

a map can be requested and displayed while the dispatcher is talking with the person reporting the incident and used to help identify landmarks, or these maps can be used to direct the approach and placement of units and lines at an incident. The Map Display has ample capacity to identify and display other types of documents--freeways, water mains, sewers, storm drain systems, and such--as well as special procedures designed for unusual situations. Names, addresses, and phone numbers of agencies and personnel and any other information needed for command and control operations can also be stored.

4. SYSTEM RELIABILITY

Since a fire-department dispatch system must be available for use at all times, the system design must not permit random equipment failures to significantly delay the dispatching process. Thus a highly reliable system was required, and toward this end a number of state-of-the-art techniques were applied.

The first step in the reliability program was to utilize equipments that had a high inherent reliability--for example, integrated circuit computers. Then the major elements of the system (such as the data processing equipments) were duplicated to provide active redundancy. Thus with redundant computers operating back-to-back, the operation of the system would be assumed by the remaining computer if either one failed.

System reliability was also enhanced through continuous testing, both manual and automatic. The computer, when not involved in a dispatch, will continuously check itself and the other system elements. For example, the computer will supervise the audio and teletype lines to the fire stations; the teletype and other equipment in the stations; and the equipment in the dispatch office.

Finally, at least one manual backup was provided for each system function, and most have more than one backup. These manual backups still satisfy the single-point operation philosophy, since they will not require dispatch personnel to leave their consoles.

5. HUMAN FACTORS

In complex systems such as the one described, the overall effectiveness is a function of how well the equipment is designed to accommodate the human operator. The design must take into account human-engineering and related factors that affect human performance. Throughout this system development program such factors as operator/machine interfaces, operator environments, personnel procedures, and fire-service traditions were investigated in order that critical factors could be identified and accounted for in the design of the facility and its equipment.

A very important human-factors consideration is operational procedures. To simplify and facilitate the transition to the new C&C system, the initial operating procedures were established as similar as possible to the present procedures. These initial operating procedures will be refined and expanded as operator experience is gained with the system.

In addition to these human factors requirements that were established for the C&C System, human factors requirements were also established for the C&C Center facilities. For example, it was determined that the operations, or dispatch room should be a sound proof area with low ambient light and with restricted access.

6. CONCLUSION

✓ This paper describes a fire department C&C system which is more advanced than any existing system. However, nothing in the system is new or "way out". In fact, identical equipments performing similar functions have been in operation for a number of years. The application of this technology to the fire service is the part of this project that is new.

The success of this project is largely due to the fact that it was a coordinated team effort involving the Los Angeles City Fire Department, the Department of Public Utilities and Transportation, and ARINC Research Corporation. Each element of this team provided unique knowledge and experience which was combined to effectively develop an optimum fire department Command and Control System for the City of Los Angeles.

This C&C System is extensive since it was designed for one of the largest cities in the world; however, a similar system with most of the capabilities that have been described can be provided to meet the needs and budgets of fire departments of any size. ↗

ED
78